

Name _____ Period _____

Chapter 8: An Introduction to Metabolism

Concept 8.1 An organism's metabolism transforms matter and energy, subject to the laws of thermodynamics

1. Define *metabolism*.
2. There are two types of reactions in metabolic pathways: *anabolic* and *catabolic*.
 - a. Which reactions release energy?
 - b. Which reactions consume energy?
 - c. Which reactions build up larger molecules?
 - d. Which reactions break down molecules?
 - e. Which reactions are considered “uphill”?
 - f. What type of reaction is photosynthesis?
 - g. What type of reaction is cellular respiration?
 - h. Which reactions require enzymes to catalyze reactions?
3. Contrast *kinetic energy* with *potential energy*.
4. Which type of energy does water behind a dam have? A mole of glucose?

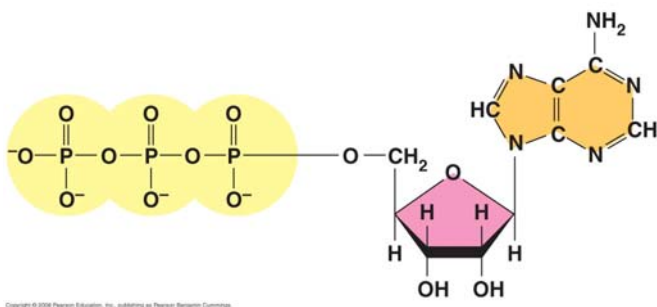
Concept 8.2 The free-energy change of a reaction tells us whether the reaction occurs spontaneously

5. What is *free energy*? What is its symbol?

6. For an exergonic reaction, is ΔG negative or positive?
7. Is cellular respiration an endergonic or an exergonic reaction? What is ΔG for this reaction?
8. Is photosynthesis endergonic or exergonic? What is the energy source that drives it?
9. To summarize, if energy is released, ΔG must be what?

Concept 8.3 ATP powers cellular work by coupling exergonic reactions to endergonic reactions

10. List the three main kinds of work that a cell does. Give an example of each.
 - (1)
 - (2)
 - (3)
11. Here is a molecule of ATP. Label it. Use an *arrow* to show which bond is likely to break.



- a. By what process will that bond break?
- b. Explain the name *ATP* by listing all the molecules that make it up.
12. When the terminal phosphate bond is broken, a molecule of inorganic phosphate P_i is formed, and energy is _____?
- For this reaction: $ATP \rightarrow ADP + P_i$, $\Delta G =$ _____
- Is this reaction endergonic or exergonic?

FYI: An essay question on the 2009 AP Biology exam asked students to identify the molecules that make up ATP. What are they again?

13. What is *energy coupling*?

In many cellular reactions, a phosphate group is transferred from ATP to some other molecule in order to make the second molecule less stable. The second molecule is said to be _____.

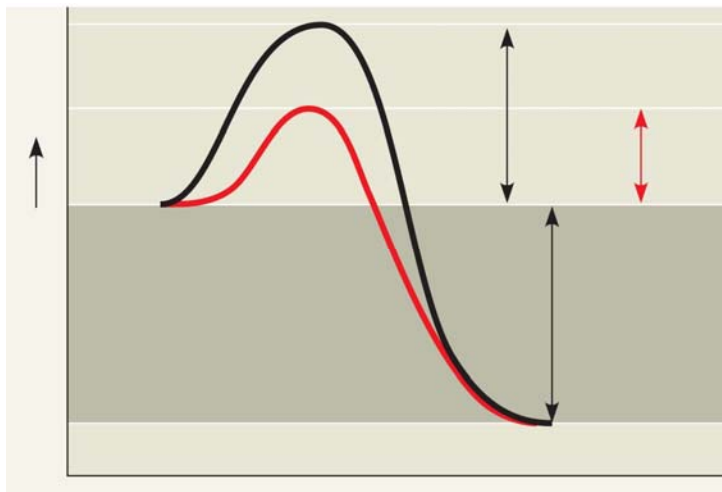
14. Look for this amazing bit of trivia: If you could not regenerate ATP by phosphorylating ADP, how much ATP would you need to consume each day?

Concept 8.4 Enzymes speed up metabolic reactions by lowering energy barriers

15. What is a *catalyst*?

16. What is *activation energy* (E_A)?

On the graph, label the x-axis “Progress of the reaction” and the y-axis “Free Energy.”
Label E_A on this sketch, both with and without enzyme.



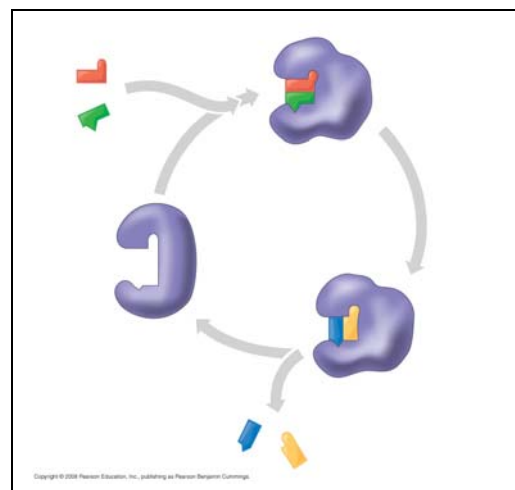
- What effect does an enzyme have on E_A ?
 - Label ΔG . Is it positive or negative?
 - How is ΔG affected by the enzyme?
17. Label this figure while you define each of the following terms:

enzyme

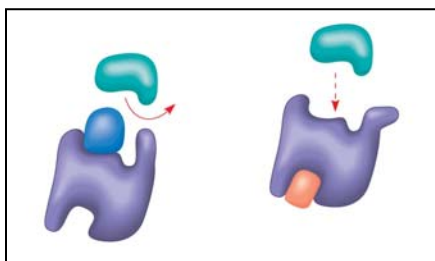
substrate

active site

products

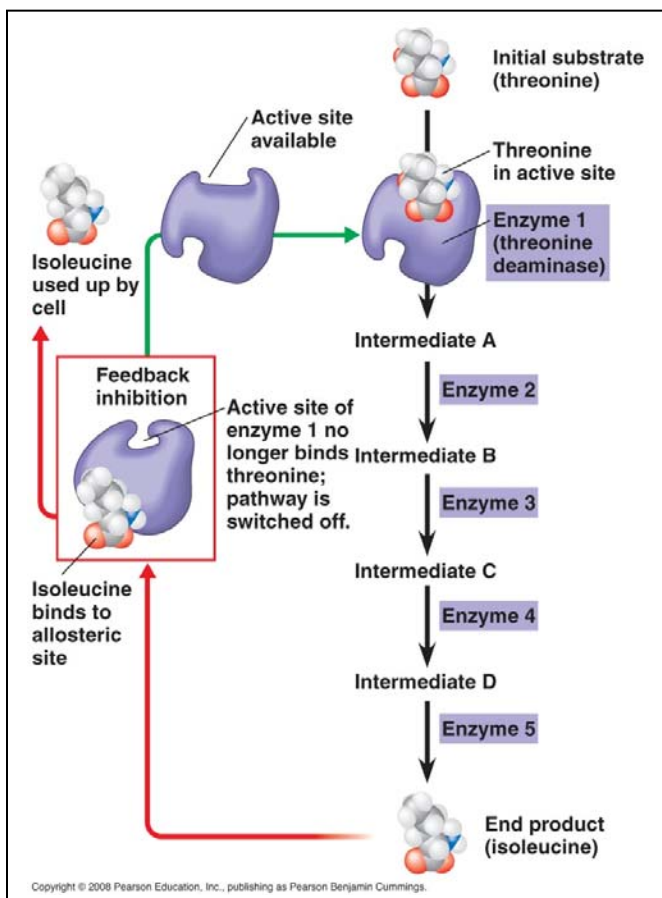


18. What is meant by *induced fit*? How is it shown in this figure?
19. Explain how protein structure is involved in enzyme specificity.
20. Enzymes use a variety of mechanisms to lower activation energy. Describe four of these mechanisms.
- (1)
- (2)
- (3)
- (4)
21. Many factors can affect the rate of enzyme action. Explain each factor listed here.
- a. initial concentration of substrate
- b. pH
- c. temperature
22. Recall that enzymes are globular proteins. Why can extremes of pH or very high temperatures affect enzyme activity?
23. Name a human enzyme that functions well in pH 2. Where is it found?
24. Distinguish between *cofactors* and *coenzymes*. Give examples of each.
25. Compare and contrast *competitive inhibitors* and *noncompetitive inhibitors*. Label each type of inhibitor in this figure.



Concept 8.5 Regulation of enzyme activity helps control metabolism

26. What is *allosteric regulation*?
27. How is it somewhat like noncompetitive inhibition? How might it be different?
28. Explain the difference between an allosteric activator and an allosteric inhibitor.
29. Although it is not an enzyme, hemoglobin shows *cooperativity* in binding O₂. Explain how hemoglobin works at the gills of a fish.
30. Study this figure from your book (Figure 8.22).



- a. What is the substrate molecule to initiate this metabolic pathway?
- b. What is the inhibitor molecule?
- c. What type of inhibitor is it?
- d. When does it have the most significant regulatory effect?
- e. What is this type of metabolic control called?

Testing Your Knowledge: Self-Quiz Answers

Now you should be ready to test your knowledge. Place your answers here:

1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____